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Methods of preventions of viral contamination from various surfaces using radiations and mechanic waves: Review

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ABSTRACT

Virus is microparasites capable of multiplication in living cells only. They use cell machinery to reproduce themselves. Most viruses consists of genetic material as DNA or RNA that can be either double or single stranded which is covered by protein or lipid capsid. Complexity of encoding enzymes can range from 4-200 proteins. Viral attack can induce innate immunity and mount cellular and humoral immune response No antibiotic can show lethal action to virus hence physical, mechanical and chemical killing of virus is done. In this paper we will discuss about eradication of viral particles using mechanic waves and radiations such as microwave, electromagnetic radiations, laser pulse, ultra violet radiations, ultra sound waves etc.

Keywords: Virus, Decontamination, radiation, waves, UVC.

INTRODUCTION

In past few years, many efforts have been taken to resist airborne diseases caused by virus such as SARS (severe acute respiratory syndrome) corona virus and influenza virus. These viruses could cause catastophic illness in worldwide and harm population at large scale. These viral epidemic preventions are required in open public area with high efficiency devices. The prevention steps include strong chemical inactivation, microwave heat treatment and UV radiations, however all these methods affects public area and population as well. Viruses are capable of absorbing ultrasonic waves and can be inactivated by generating corresponding resonance ultrasound vibrations in GHz region [2]. In 2015, Szu-chi- Yang suggested that structure energy resonance transfer (SRET) can be effective to inactivate virus by using microwave thermal heating at particular frequency. Theoretically this SRET process is an efficient way to excite the vibrational mode of whole virus structure due to 100% energy conversion of a photon to phonon of same frequency. The SRET, however have some limitations and got affected due to surrounding environment which influence the quality of oscillator

(Virus). It is important to study the behaviour, phenomena, threshold and impact of SRET as they are being exposed to public area. The study of relation between induced stress and field magnitude of the illuminating microwave is necessary since the virus could be inactivated when the induced stress fracture the conformation of viral particle.

Ultrasound is another way to disintegration of virus structure which are having highly symmetric structures (icosahedral) such as Herpes simplex virus [4], because of buckminsterfullerene type fullerene which has soccer ball or cage like structure which show high symmetry for disintegration of icosahedral viral molecule. A fullerene molecule consists of 60 atoms of carbon having high frequency of disintegration of molecule. A similar simplicity can also be expected in HIV viral molecule [5]. The frequency of disruption can be calculated by using sound wave equation $f=C/\lambda$, where f is resonant frequency velocity, C is velocity and λ is wavelength [6]. By analogy it is said that the virus resonant ultra sound energy would be absorbed preferentially by virus which may lead to their inactivation and partial damage.

In another study Constantinos V. Chrysikopoulos use the high frequency ultrasound in combination with visible light. Their studies were done in order to detect and decontaminate the water borne virus. However commonly used disinfection processes were using since long ago that includes ozonization, chlorination, and ultraviolet radiation already but it is important to note that these chemical methods of disinfection is harmful to the users as well. Apart from this, several more expensive methods have been introduced such as streamer corona discharge, high energy electron beams, photocatalysis, irradiation, ultrasound, gamma radiation and many more.

One more experimental step towards this goal of prevention is to use microwave radiation absorption. Microwave helps to transfer microwave excitation energy to vibrational energy of microorganisms. Impulsive Stimulated Raman Scattering (ISRS) allow a viable way of producing large amplitude vibrational mode in solid state system as well as in liquid state [7]. KT Tsen in 2007 demonstrated that M13 bacteriophage at a particular pfu concentration is helpful in controlling and inactivating the unwanted microorganism. The study shows that the use of visible femtosecond laser system to excite a coherent acaustic Raman active vibrational mode in M13 phages through ISRS to such a high energy state to inactivate virus. In addition, since structural change due to the mutation of microorganisms leads to slight

differentiation of the vibrational frequency of their capsids, damage caused to viruses through vibration of their mechanical structures likely would not be immune to simple mutation of receptors on their cell surface and similar treatment procedure remains active.

A most striking way to kill virus is the exposure of sunlight or can say solar UV radiation which acts as principal and abundant natural virucide in environment. UV radiation inactivate the virus by changing their structure of DNA or RNA. The most effective wavelength at which virus can be inactivated is at 265 nm [8] that fall in UVC range whereas UVB and UVA portions of the spectrum, 290 to 320 nm and 320 to 380 nm, respectively [9]. However UVB and UVA also show effect on viral DNA but with lower efficiency. C. David Lytle, 2005 studied that on exposure to UV_{254} radiation on a low pressure mercury vapour (Germicidal lamp) with the primary exposure at 254 nm. However UV_{254} is not found in the sunlight which reaches to the earth's surface, the ground level virucidal solar UV wavelength fall above 290 nm [10].

Fortunately the primary photochemical process can damage the DNA or RNA The nucleic acid in virus particle plays an important role in the absorption of UV radiation and in its inactivation. In most viruses the other major constituents of the virus particles play relatively minor roles in inactivation by UV [8]. The number of bases in DNA or RNA is important for determination of sensitivity to UV inactivation, because the more target molecules, the more likely the genome will be damaged at a given wavelength of UV exposure. Another noticeable difference in sensitivity between viral nucleic acid types occurs because the most common lethal photoproducts of UV are pyrimidine dimers, particularly thymine dimers [11]. The DNA containing virus show more susceptibility than RNA containing virus because of presence of thymine [12, 8].

These sensitivities can be used to predict the sensitivities to UV 254 of viruses of particular interest in biodefense, including Ebola, smallpox, Marburg, Junin, Congo Crimean, and other Venezuelan equine encephalitis and hemorrhagic viruses. Vaccinia virus also show significant inactivation at Upper-room 254-nm germicidal UV (UVC) light and economical means of air disinfection for tuberculosis and other airborne infections [13, 14, 15,16]. If organisms circulate from the lower room to the upper room (i.e., if there is adequate mixing of room (atmospheric) air) and receive an adequate dose of UVC, upper-room UVC can potentially lower the concentration of infective organisms in the

lower part of the room and thereby control the spread of airborne infections among room occupants without exposing the occupants to a significant amount of UV radiation [13, 15, 17].

Do-Kyun Kim, 2018 also reported that Severe Accute Respiratory Syndrome- CoV (CoronaVirus) IN 2003 and Swine flu influenza virus H1N1 in 2009 stimulate the process of disinfection and development of air purification system to control microorganism such as bacteria, virus and fungi [18]. Dimerization of pyrimidine disturbs DNA replication and transcription, which leads to cell death [19, 20, 21]. Until now,UV irradiation has mostly been performed with conventional low-pressure mercury UV lamps (LP lamps), which emit a 254-nm peak wavelength.

Conclusion: It has shown that micoorganism such as bacteria, virus and fungi have particular range of inactivation in case of radiations such as microwave, electromagnetic radiations, laser pulse, ultra violet radiations, ultra sound waves etc. Few works demonstrated the modification in the study to eradication of viral contamination in open air, in solid state or in liquid state, in aerosols (tiny droplets released during sneezing of infected person), although the viral contamination can only be destroyed at the ground level but cannot alter the immune system. The excitational or vibrational energy disturb the conformation of viral capsid, whereas other radiations such as UVC cause the structural changes in their genetic material like DNA and RNA. Use of open air source of radiations or closed chamber can be effectively fitted in public area to control and inactivate viral particles.

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